Changes of the cryosphere and linkages to space observable biodiversity indicators

Annett Bartsch & CHARTER remote sensing team

b.geos, UEF, UOXF, FMI, LAY, NINA, UiT, UA, UZH, UCL …

Biodiversity change indicators from satellite data?

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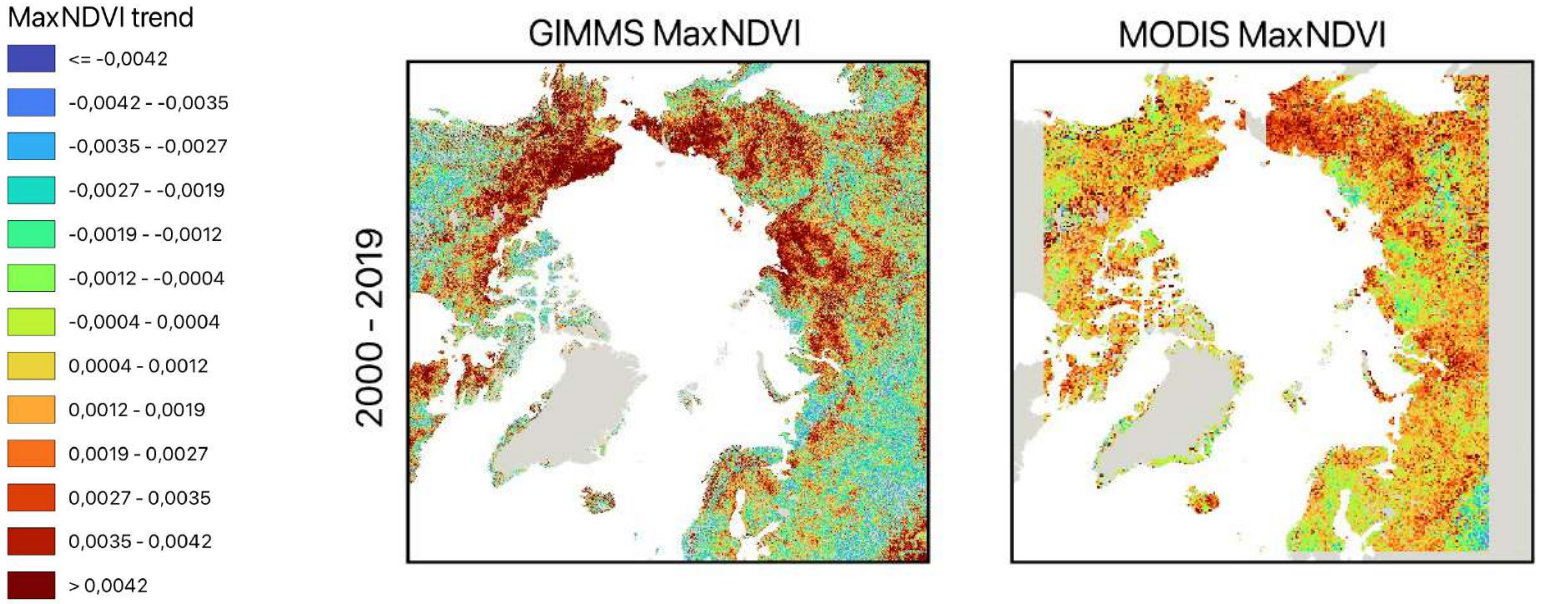
NDVI commonly used – annual datasets: MaxNDVI, TI-NDVI



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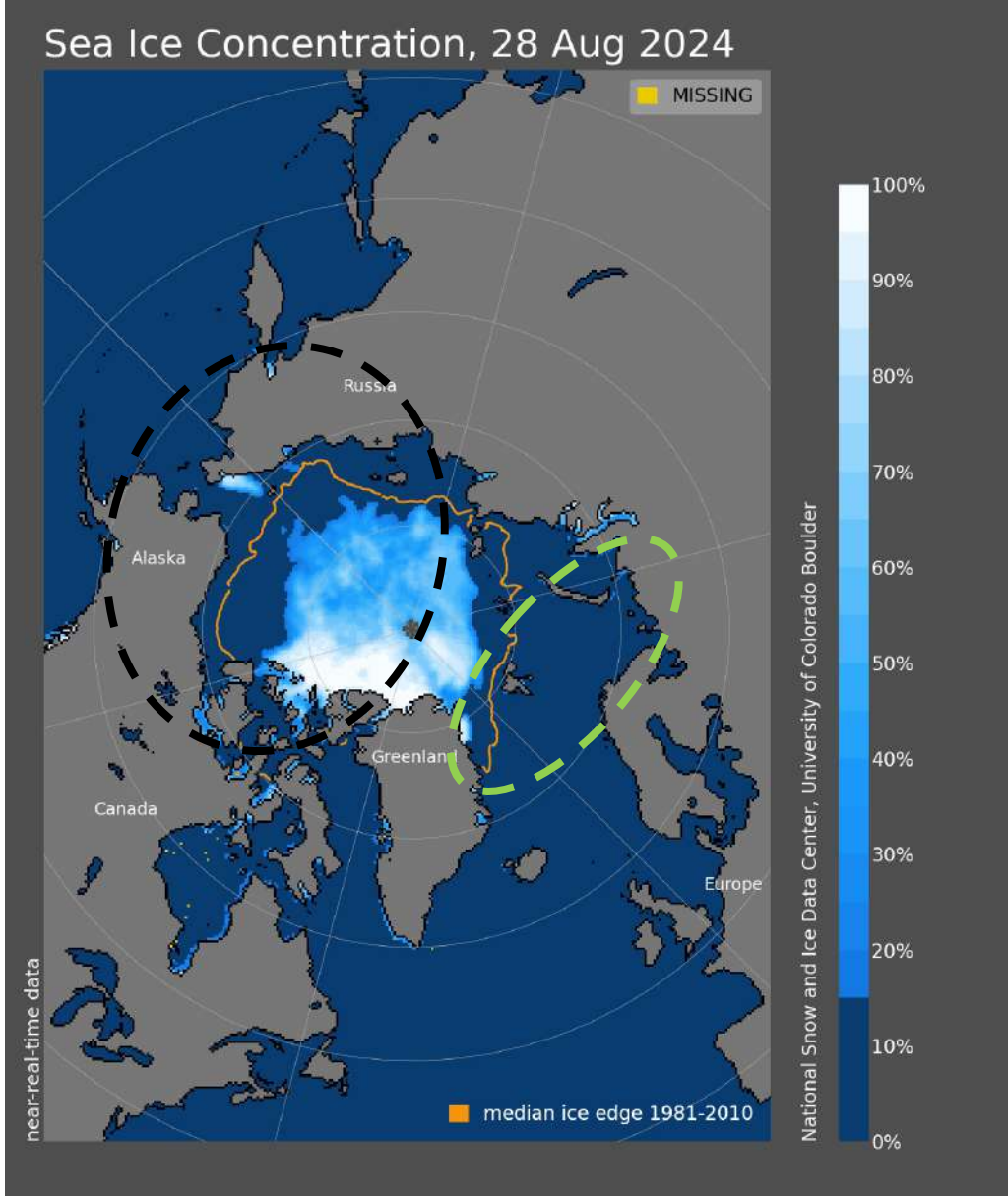
Sea ice and NDVI

e.g. circumpolar studies

- Bhatt et al. (2010): Significant trend relationship for Eastern Siberia and Canadian Archipelago (use of AVHRR)
- Bhatt et al. (2021): MaxNDVI significant trend relationship only for Northern America (detrended AVHRR/GIMMS)

+ Several regional studies with focus on specific sea ice basins (NE Greenland, Svalbard, Western Siberia)



Sea ice and Rain-on-Snow– potential relationship

- Discussion in Forbes et al. (2016) related to cases on the Yamal peninsula (reported severe impacts on reindeer herds)

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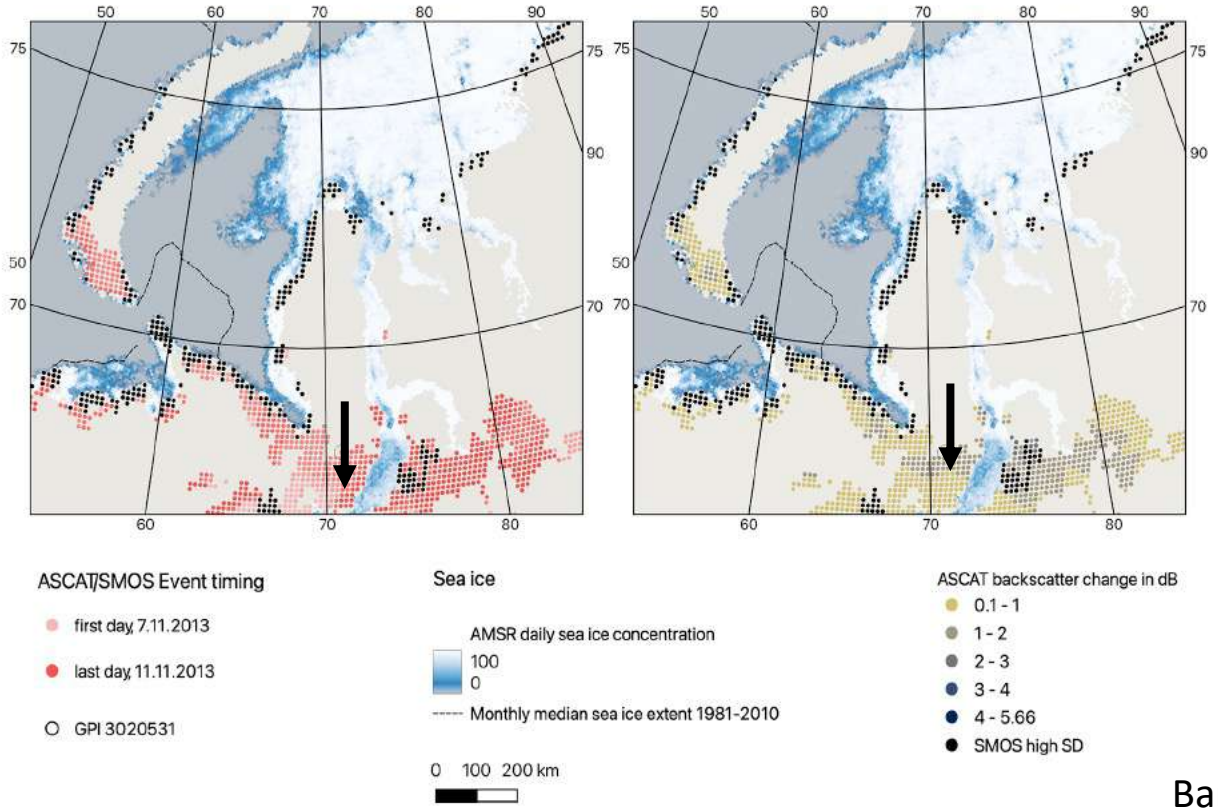
MetOp ASCAT grid points with a detected event (snow structure change) in November 2013 and sea ice concentration

(9 November 2013 and long-term November average; SIC source: University of Bremen; Spreen et al., 2008).



Migration route of reindeer herds

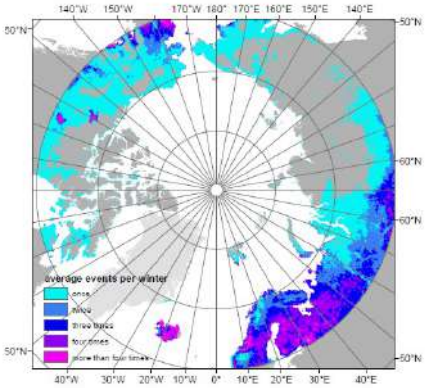
Bartsch et al. (2023), The Cryosphere

Climate data record retrieval scheme development in permafrost cci

in situ cal/val facilitated through CHARTER

> 300 snow pit records by UIT, FMI, and herders

Sensors investigated for ROS



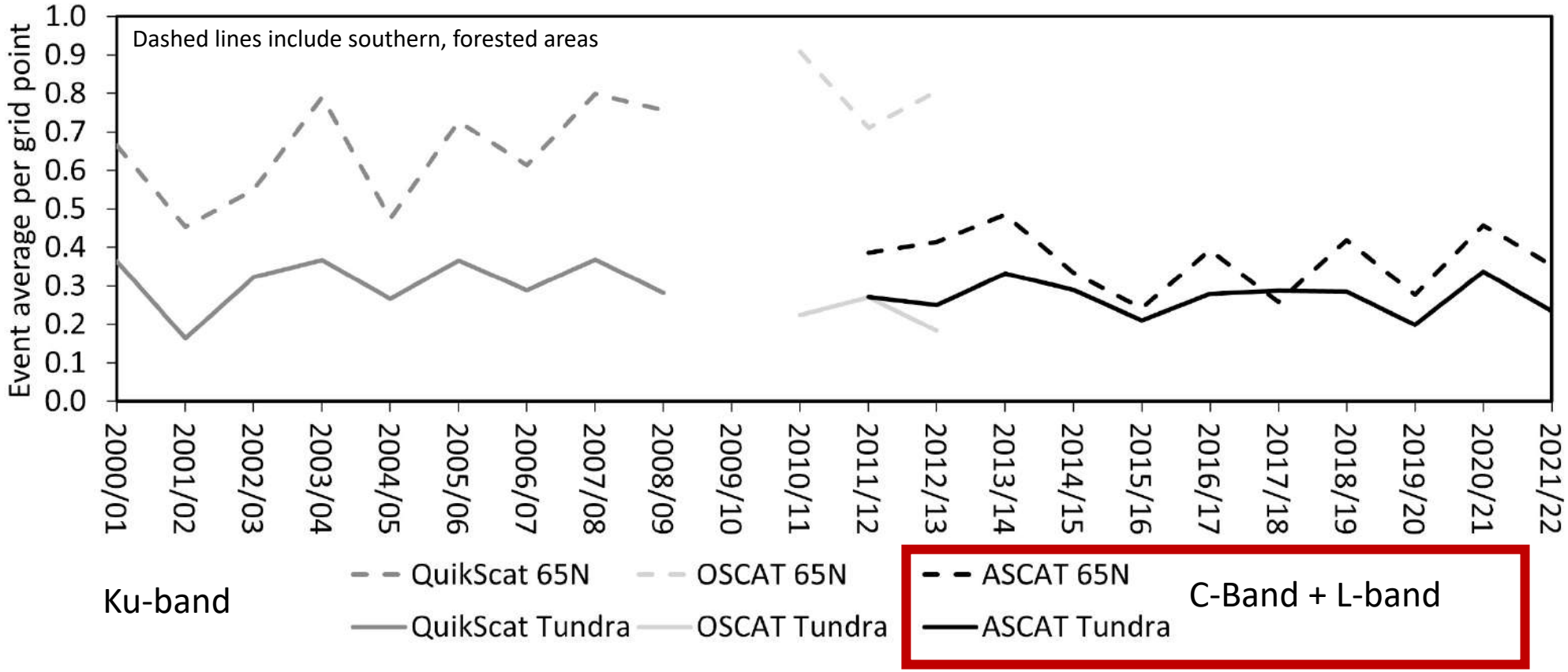
Bartsch (2010)

	band & grid		
2000 – 2009 QuikScat ROS	K_u 10 km	radar	
11/05/2010 – 02/20/2014 OSCAT BYU BS	K_u 4.4 km	radar	"new"
2007 ASCAT EUMETSAT BS	C 12.5 km	radar	
2015 Sentinel-1 BS	C 10-30m	radar	
2011 SMOS CATDS BT	L 25 km	passive microwave	

Bartsch et al. (2023), The Cryosphere

Climate data record retrieval scheme development in permafrost cci in situ cal/val facilitated through CHARTER

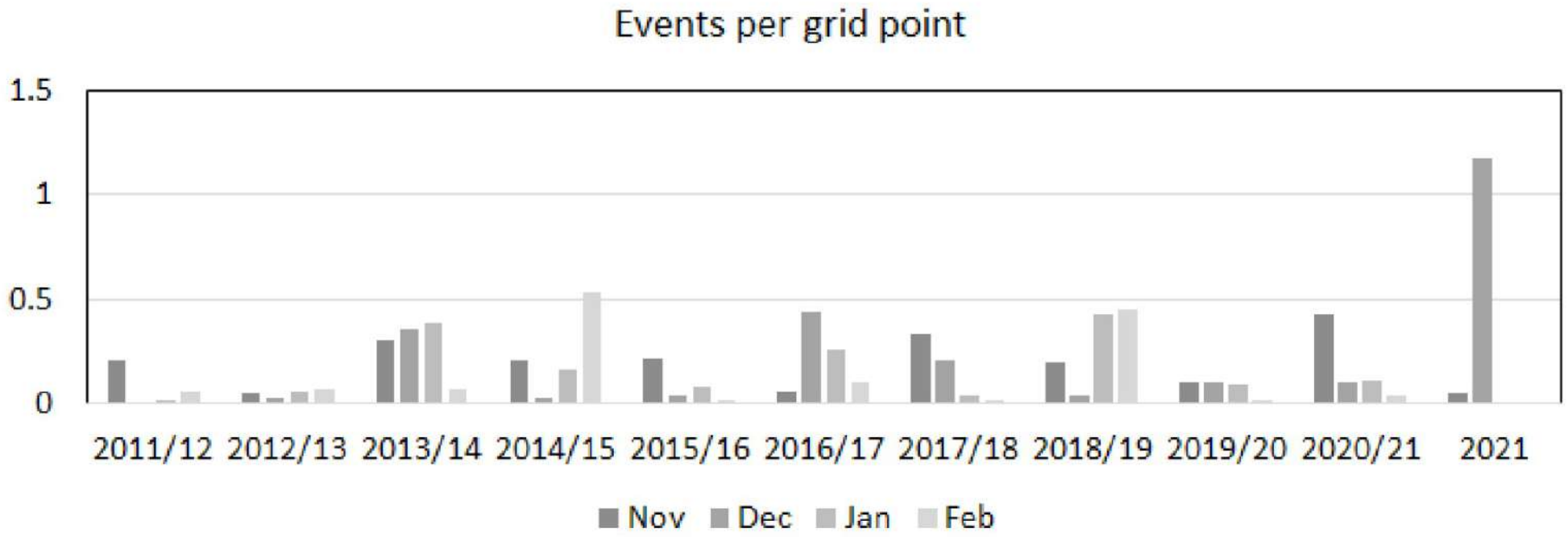
- No trends for mid-winter (Nov-Feb) since 2000 (longer time range reananlyses studies show trends in some areas)
- No specific sea ice pattern for reported cases in Western Siberia



Bartsch et al. (2023), The Cryosphere

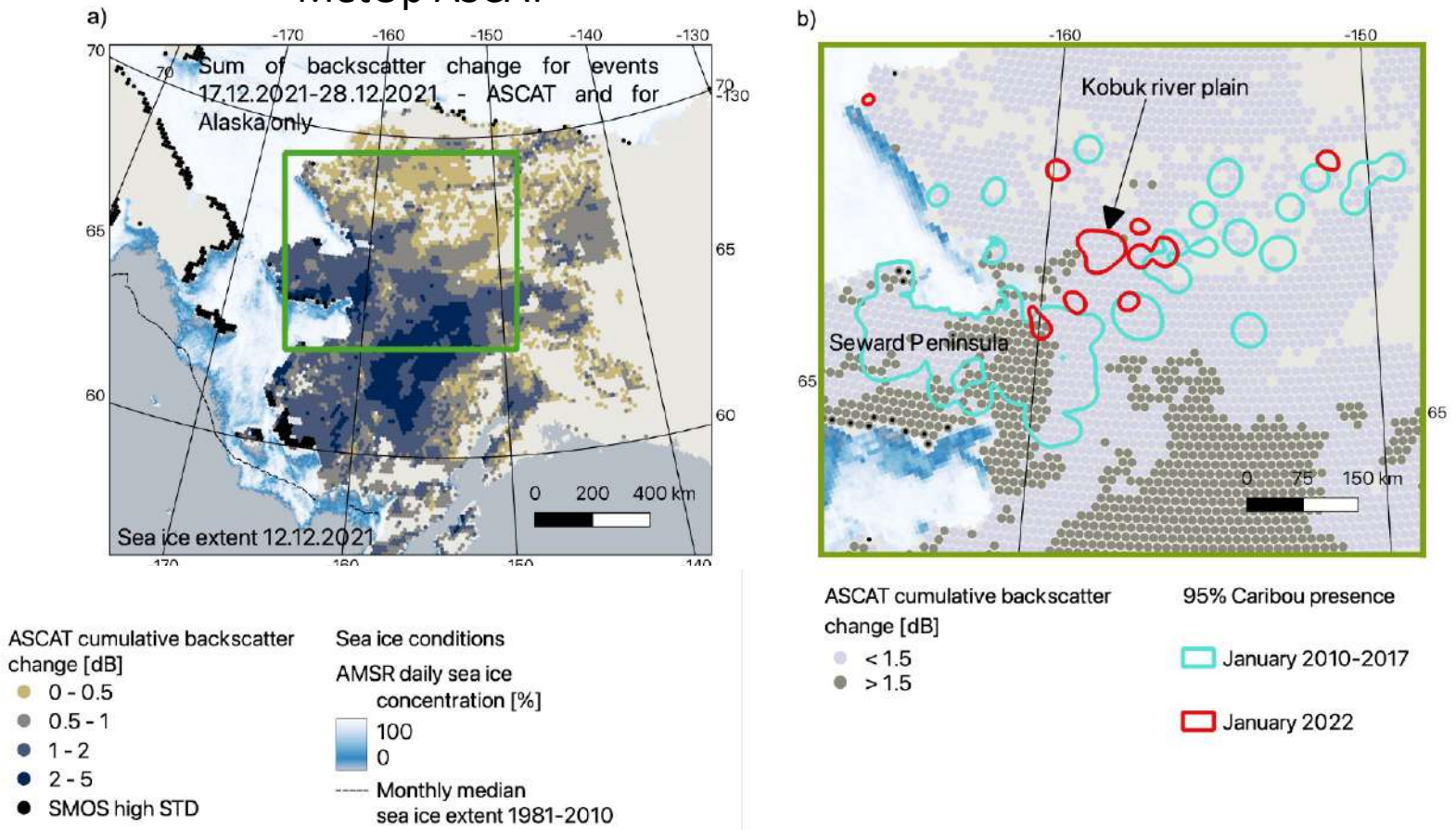
But regional extremes can be documented

ROS time series example – Seward peninsula, Alaska



Bartsch et al. (2023), The Cryosphere

MetOp ASCAT



Change in Caribou migration

"Normal years"

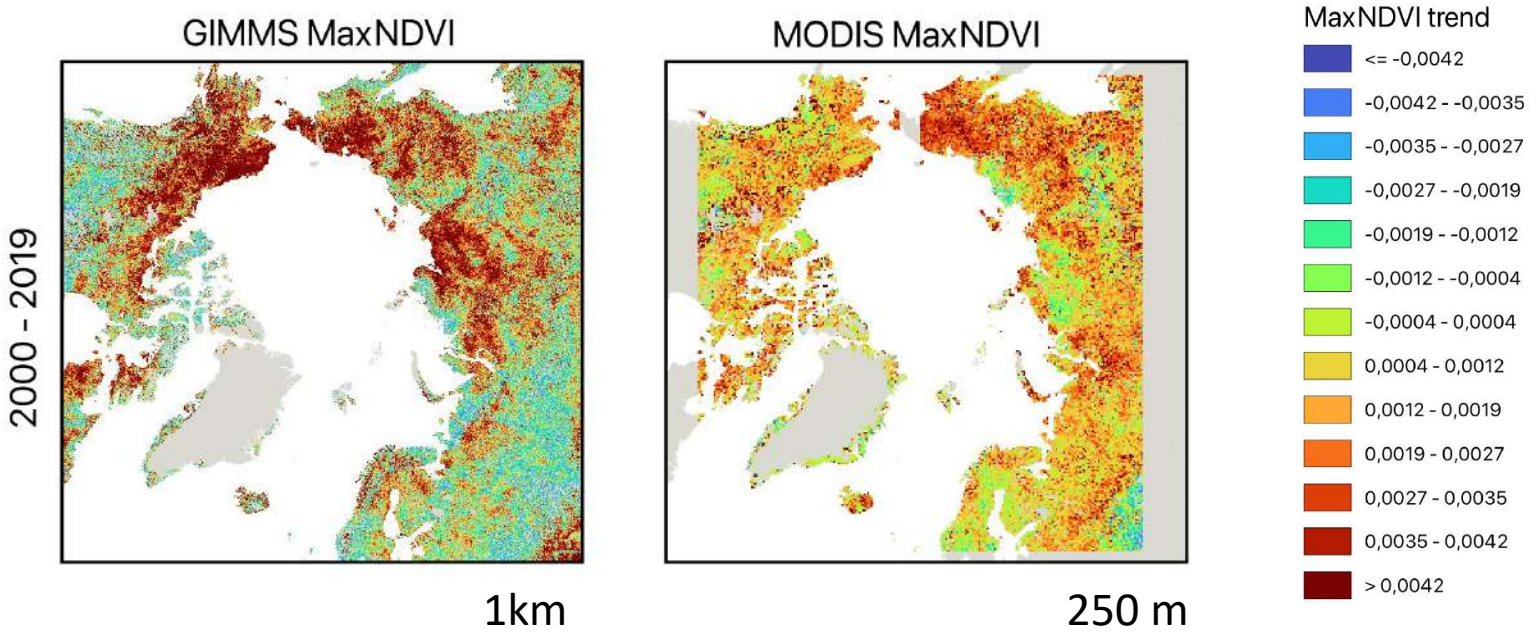
2022

- Other studies also document ROS impact on vegetation for Svalbard (in situ and NDVI), e.g. Bjerke et al. (2017) and related fluxes (Treharne et al. 2020).

Bartsch et al. (2023), The Cryosphere

Greening indicated through NDVI

- Potentially shrubification in transitions zones – comparably slow



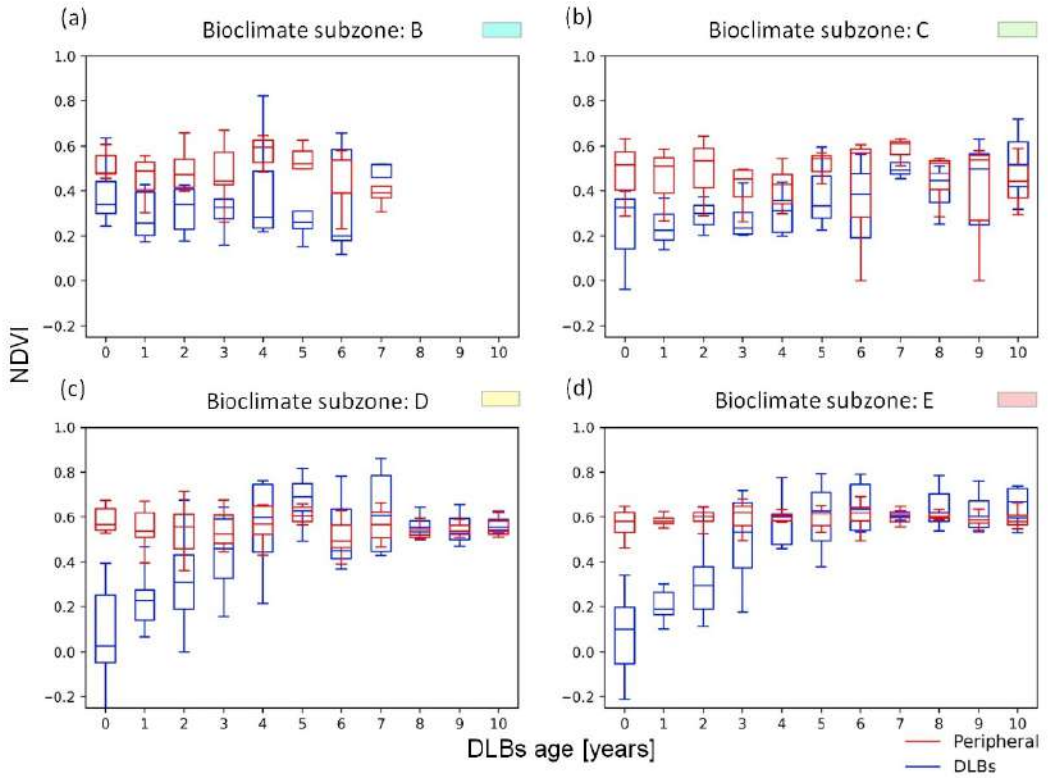
Bartsch & CHARTER team (in prep.)

Greening indicated through NDVI

- Potentially shrubification in transitions zones – comparably slow
- Vegetation recovery after thaw lake drainage – within a few years

Sentinel-2 NDVI (10m)
Space for time approach

surrounding
drained lake basin



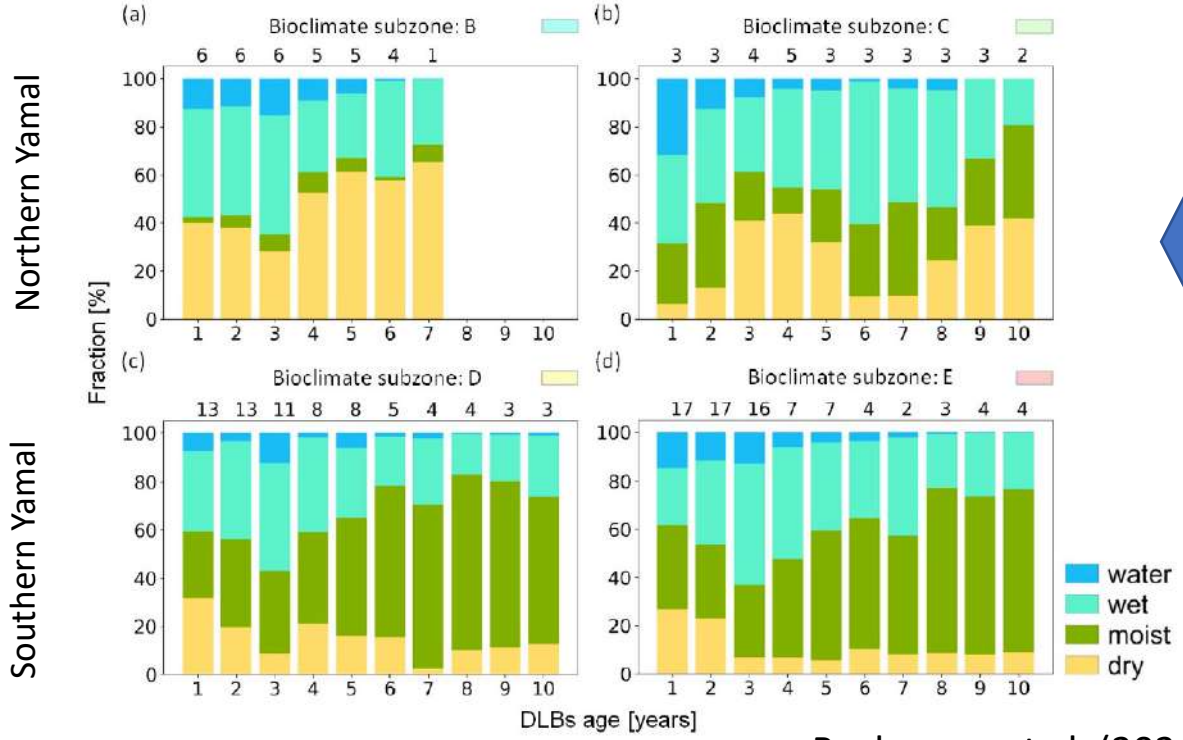
Northern Yamal

Southern Yamal

Greening indicated through NDVI

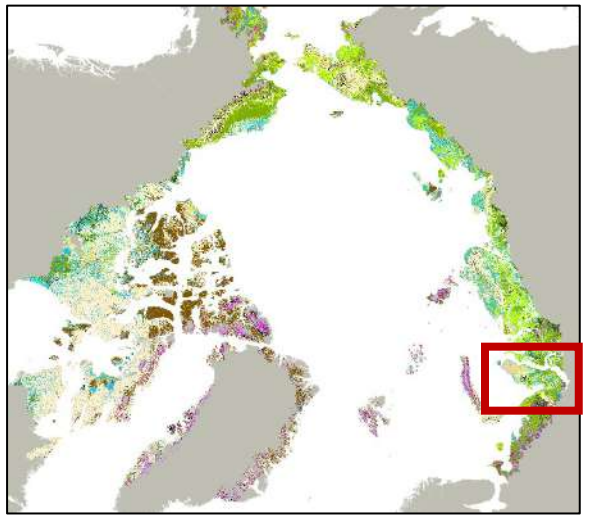
- Potentially shrubification in transitions zones – comparably slow
- Vegetation recovery after thaw lake drainage – within a few years

Similar green-up (NDVI) after a few years, but different habitat condition trajectories



v. Beckmann et al. (2024)

New landcover from ESA CCI Permafrost (CALU beta version, 10m, Sentinel-1/2), representing tundra vegetation and moisture gradients

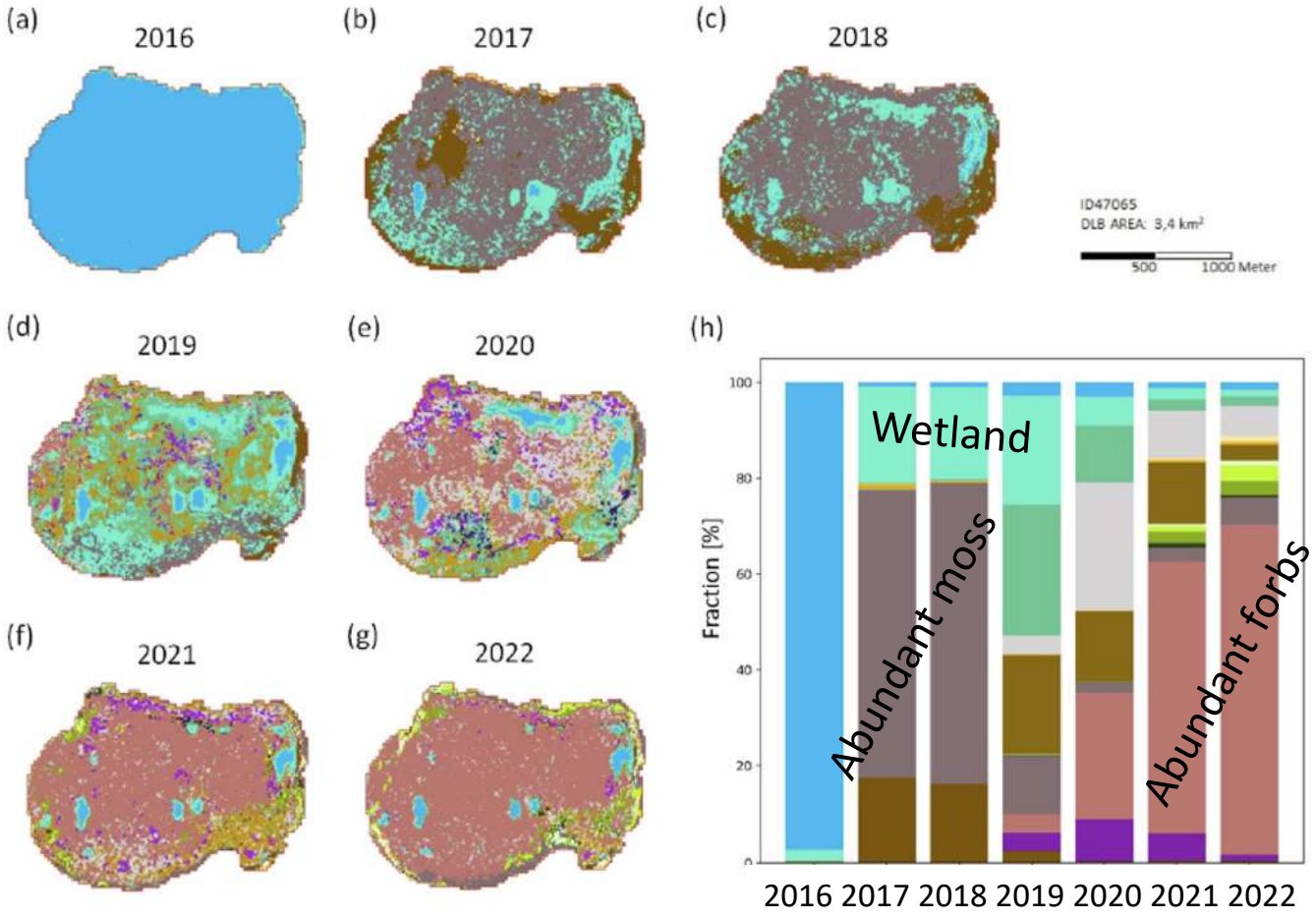


Bartsch et al. (2024)

Also prototype for tundra vegetation height available (ESA DUE GlobPermafrost)

Northern zone: change from barren to abundant lichen tundra type
Southern zone: change from abundant moss/wetland to abundant forbs tundra type

Southern Yamal example



v. Beckmann et al. (2024)

Satellite data for biodiversity related issues (land)

- NDVI, including sea ice linkage – differences between sensors used for NDVI retrieval
- + permafrost related changes through landcover – high spatial resolution and thematic content needed
- + snow properties (e.g. changes by rain-on-snow) – reliable retrieval currently limited to tundra

- Use of ESA CCI data in CHARTER: permafrost, snow, sea ice